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(54) **AIRPLANE ANTENNA CONTROL DEVICE, AIRPLANE, AIRPLANE ANTENNA SELECTION PROGRAM, AND AIRPLANE ANTENNA CONTROL METHOD**

FLUGZEUGANTENNENSTEUERUNGSVORRICHTUNG, FLUGZEUG,
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DISPOSITIF DE COMMANDE D'ANTENNE D'AVION, PROGRAMME DE SÉLECTION D'ANTENNE
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Description

{Technical Field}

[0001] The present invention relates to aircraft-antenna controlling devices, aircrafts, aircraft-antenna selecting programs, and aircraft-antenna controlling methods.

{Background Art}

[0002] There are cases where aircrafts that are capable of shooting, searching for, and tracking targets shoot the targets being searched for and tracked.

[0003] As an example of this type of aircraft, Patent Literature 1 describes an aircraft that searches for, tracks, and shoots a target by way of the integrated use of an active target searching and tracking device and a passive target searching and tracking device that is capable of searching for and tracking a target without radiating electromagnetic waves.

{Citation List}

{Patent Literature}

[0004]

{PTL 1} Publication of Japanese Patent No. 3736112

{Summary of Invention}

{Technical Problem}

[0005] In order to perform searching, tracking, etc. of a target more effectively, it is necessary to share various kinds of information between an aircraft and a wingman aircraft. However, since the positional relationship between the wingman aircraft and the aircraft changes with time, there are cases where the aircraft fails to establish communication with the wingman aircraft if it fails to select an antenna that is suitable for communication with the wingman aircraft.

[0006] JP 2000 235070 A discloses a communication system composed of an ECM and an ESM mounted on a first aircraft. The ECM is provided with a transmitting means for transmitting a disturbing radio wave to a target, and for transmitting modulatingly a communication signal to the second aircraft of a communication object mounted with an ESM for receiving a radio wave from a target to be analyzed. The ESM is provided with a demodulating means for receiving a communication signal from the second aircraft of the communication object mounted with the ESM, to be demodulated. The communication signal might be transmitted using a narrowed beam.

[0007] US 2009 103473 A1 discloses an ad-hoc communication network including at least two vehicles such as at least two aircraft. Each vehicle includes surveillance equipment, a surveillance transmitter, a surveillance re-

ceiver, a communication management function (CMF), a communication transmitter, and a communication receiver. The surveillance equipment is configured to generate at least position and ID information. The surveillance transmitter is configured to transmit the at least position and ID information. The surveillance receiver is configured to receive at least position and ID information from other vehicles. The communication management function (CMF) is configured to determine a network topology based on the received at least position and ID information and determine a route for a communication signal based on the determined network topology and the communication transmitter is configured to transmit the communication signals to a select communication receiver pursuant to the determined route.

[0008] JP 2008 180636 further discloses an aircraft concerned having received radar wave from a target aircraft, which transmits a jamming signal, and commands an accompanying aircraft to receive the jamming signal transmitted by the aircraft concerned via a data link. The accompanying aircraft receives the jamming signal based on the command, detects the radiowave data, and determines correlation with the jamming signal information transmitted via the data link, thereby determining the jamming state by the jamming signal. The accompanying aircraft transmits the results to the concerned aircraft side via the data link, thereby allowing the concerned aircraft side to obtain the degree of self-defense by the jamming.

[0009] The present invention has been made in view of this situation, and it is an object thereof to provide an aircraft-antenna controlling device, an aircraft, an aircraft-antenna selecting program, and an aircraft-antenna controlling method with which it is possible to select an antenna that is optimal for communication with a wingman aircraft from among multiple antennas.

{Solution to Problem}

[0010] According to the present invention the above object is achieved by an antenna controlling device according to claim 1, and aircraft according to claim 5, and antenna selecting program according to claim 6 and an antenna controlling method according to claim 7. The dependent claims are directed to different advantageous aspects of the invention.

[0011] In order to solve the problem described above, the aircraft-antenna controlling device, the aircraft, the aircraft-antenna selecting program, and the aircraft-antenna controlling method according to the present invention employ the following solutions.

[0012] An aircraft-antenna controlling device according to a first aspect of the present invention is an antenna controlling device for an aircraft having multiple antennas for communicating with a wingman aircraft, the multiple antennas being provided at different points on a fuselage, the aircraft-antenna controlling device including a wingman-aircraft-position predicting means for predicting the current position of the wingman aircraft based on a tem-

poral change in position information indicating the position of the wingman aircraft; a selecting means for selecting, from among the multiple antennas, an antenna with which the elongation with respect to the center axis of the antenna at the current position of the wingman aircraft predicted by the wingman-aircraft-position predicting means falls within a coverage angle; and a communication controlling means for executing communication with the wingman aircraft via the antenna selected by the selecting means.

[0013] The aircraft-antenna controlling device according to this configuration is an aircraft-antenna controlling device having multiple antennas for communicating with a wingman aircraft, the multiple antennas being provided at different points on a fuselage. Since the aircraft and the wingman aircraft are moving relative to each other, there are cases where the aircraft fails to establish communication with the wingman aircraft if it fails to select an antenna that is suitable for communication with the wingman aircraft.

[0014] Thus, the current position of the wingman aircraft is predicted by the wingman-aircraft-position predicting means based on a temporal change in position information transmitted from the wingman aircraft and indicating the position of the wingman aircraft. As described earlier, the aircraft and the wingman aircraft are moving, so that even if wingman-aircraft position information is received, the position of the wingman aircraft indicated by the position information is a past position of the wingman aircraft. Thus, it is necessary to predict the current position of the wingman aircraft based on the wingman-aircraft position information.

[0015] Then, an antenna with which the elongation with respect to the central axis of the antenna at the predicted current position of the wingman aircraft falls within the coverage angle is selected from among the multiple antennas by the selecting means, and communication with the wingman aircraft is executed via the selected antenna by the communication controlling means. The antenna with which the elongation falls within the coverage angle is, in other words, an antenna with which it is possible to establish communication with the wingman aircraft.

[0016] Furthermore, the amount of change in the relative position of the aircraft and the wingman aircraft strongly depends on the change in the roll of the aircraft rather than the relative velocity of the aircraft and the wingman aircraft. Thus, considering the change in the relative position of the aircraft and the wingman aircraft due to the change in the roll of the aircraft, preferably, the antenna for executing communication with the wingman aircraft should be selected based on the elongation.

[0017] Accordingly, with this configuration, it is possible to select an antenna that is optimal for communication with the wingman aircraft from among the multiple antennas.

[0018] In the first aspect described above, preferably, the coverage angle of the antenna overlaps the coverage angle of an adjacent one of the other antennas, and, in

the case where multiple antennas have been selected by the selecting means, one of the selected multiple antennas is selected based on the difference between the coverage angle and the elongation of each of the antennas.

[0019] With this configuration, since the coverage angle of an antenna overlaps the coverage angle of at least one of the other antennas, there are cases where multiple antennas are selected by the selecting means. In such cases, one of the selected multiple antennas is selected based on the difference between the coverage angle and the elongation of each of the antennas.

[0020] Accordingly, with this configuration, it is possible to select a more optimal antenna from among multiple antennas that allow communication with the wingman aircraft.

[0021] In the first aspect described above, preferably, one antenna is selected from among the antenna with the greatest difference between the coverage angle and the elongation, the antennas with which the difference is greater than or equal to a predetermined constant, and the antennas with which the difference is greater compared with the last communication.

[0022] The antenna with the greatest difference between the coverage angle and the elongation is an antenna with the greatest tolerance for communication with the wingman aircraft. Furthermore, the antennas with which the difference is greater than or equal to the predetermined constant are antennas with which it is possible to perform communication with the wingman aircraft more reliably. Furthermore, the antennas with which the difference is greater compared with the last communication are antennas with which the communication conditions with the wingman aircraft are better compared with the last communication.

[0023] With this configuration, it is possible to select a more optimal antenna by selecting one antenna from among the antennas described above.

[0024] In the first aspect described above, preferably, the antenna with the greatest difference between the center axis and the elongation, the antennas with which the difference is greater than or equal to the constant, and the antennas with which the difference is greater compared with the last communication are weighted individually by predetermined values, and the antenna with the greatest total value of the results is selected.

[0025] With this configuration, the difference between the center axis and the elongation of each of the antennas is evaluated comprehensively, and the antenna with the least elongation is selected, so that it is possible to select a more optimal antenna.

[0026] An aircraft according to a second aspect of the present invention includes multiple antennas for communicating with a wingman aircraft, the multiple antennas being provided at different points on a fuselage; and the antenna controlling device described above.

[0027] An aircraft-antenna selecting program according to a third aspect of the present invention is an antenna

selecting program for an aircraft having multiple antennas for communicating with a wingman aircraft, the multiple antennas being provided at different points on a fuselage, wherein the aircraft-antenna selecting program causes a computer to function as a selecting means for selecting, from among the multiple antennas, an antenna with which the elongation with respect to the center axis of the antenna at the current position of the wingman aircraft predicted based on a temporal change in position information indicating the position of the wingman aircraft falls within a coverage angle.

[0028] An aircraft-antenna controlling method according to a fourth aspect of the present invention is an antenna controlling method for an aircraft having multiple antennas for communicating with a wingman aircraft, the multiple antennas being provided at different points on a fuselage, the aircraft-antenna controlling method including a first step of predicting the current position of the wingman aircraft based on a temporal change in position information indicating the position of the wingman aircraft; a second step of selecting, from among the multiple antennas, an antenna with which the elongation with respect to the center axis of the antenna at the predicted current position of the wingman aircraft falls within a coverage angle; and a third step of executing communication with the wingman aircraft via the selected antenna.

{Advantageous Effects of Invention}

[0029] According to the present invention, a superior advantage is afforded in that it is possible to select an antenna that is optimal for communication with a wingman aircraft from among multiple antennas.

{Brief Description of Drawings}

[0030]

{Fig. 1}

Fig. 1 is a schematic illustration showing the relationship between an aircraft and a wingman aircraft according to an embodiment of the present invention.

{Fig. 2}

Fig. 2 is a schematic illustration showing the coverage angles of antennas according to the embodiment of the present invention.

{Fig. 3}

Fig. 3 is a block diagram showing the configuration of an antenna controlling device according to the embodiment of the present invention.

{Fig. 4}

Fig. 4 is a schematic illustration showing a velocity predicting method according to the embodiment of the present invention.

{Fig. 5}

Fig. 5 is a schematic illustration showing an acceleration predicting method according to the embodi-

ment of the present invention.

{Fig. 6}

Fig. 6 is a schematic illustration showing a circular-path predicting method according to the embodiment of the present invention.

{Fig. 7}

Fig. 7 is a schematic illustration showing the relative position of the aircraft and the wingman aircraft according to the embodiment of the present invention.

{Fig. 8}

Fig. 8 is a schematic illustration showing an elongation according to the embodiment of the present invention.

{Fig. 9}

Fig. 9 is a flowchart showing the flow of antenna selection processing according to the embodiment of the present invention.

{Description of Embodiment}

[0031] Now, an embodiment of an aircraft-antenna controlling device, an aircraft, an aircraft-antenna selecting program, and an aircraft-antenna controlling method according to the present invention will be described with reference to the drawings.

[0032] Fig. 1 is a schematic diagram showing the relationship between an aircraft 10A and a wingman aircraft 10B, which are aircrafts 10 according to this embodiment.

[0033] On the aircraft 10 according to this embodiment, multiple antennas 12 (also see Fig. 3) for communicating with the wingman aircraft 10B are installed at different points on the fuselage. The aircraft 10A and the wingman aircraft 10B communicate with each other while changing their positions as they fly. The aircrafts 10 according to this embodiment are configured such that the multiple antennas 12 allow communication between the aircraft 10A and the wingman aircraft 10B regardless of the direction in which the wingman aircraft 10B is located.

[0034] Fig. 2 is a schematic diagram showing the coverage angles of the antennas 12 of the aircraft 10. As an example, the aircraft 10 shown in Fig. 2 covers the upward, downward, leftward, and rightward directions with four antennas 12. A region in which the coverage angle of each antenna 12 overlaps the coverage angle of an adjacent antenna 12 is called an overlapping region.

[0035] Here, since the aircraft 10A and the wingman aircraft 10B are moving relative to each other, in order to ensure reliable communication between the aircraft 10A and the wingman aircraft 10B, the aircraft 10A has to ascertain the current positional relationship between the aircraft 10A and the wingman aircraft 10B and execute processing for selecting and switching to a suitable antenna 12 among the multiple antennas 12 as needed (antenna handover).

[0036] Fig. 3 is a block diagram showing the construction of an onboard terminal 20 of the aircraft 10. The onboard terminal 20 is an antenna controlling device that controls the antennas 12 of the aircraft 10A to establish

communication between the aircraft 10A and the wingman aircraft 10B and is provided in a control unit 22 of the aircraft 10. Fig. 3 mainly shows the functions of the control unit 22 related to the onboard terminal 20.

[0037] The control unit 22 includes an own-aircraft-position measuring device 24, a computer 26, and an atomic clock unit 28 in addition to the onboard terminal 20. The onboard terminal 20 and the computer 26 are constituted of, for example, a CPU (Central Processing Unit), a RAM (Random Access Memory), a computer-readable recording medium, etc. Furthermore, for example, the series of processes for realizing various functions that will be described later are recorded on a recording medium, etc. in the form of programs, and the various functions are realized by the CPU loading the programs into the RAM, etc. and processing information and executing calculations.

[0038] The own-aircraft-position measuring device 24 is, for example, a GPS (Global Positioning System) or INS (Inertial Navigation System) device, and it obtains own-aircraft position information indicating the position of the aircraft 10A itself. The own-aircraft position information is associated with the time when the aircraft 10A obtained the own-aircraft position information.

[0039] The computer 26 executes various calculations needed for the flight of the aircraft 10A.

[0040] The atomic clock unit 28 outputs information (hereinafter referred to as "time correction information") for correcting the time that is used for the various calculations executed in the aircraft 10A for the purpose of time synchronization between the aircraft 10A and the wingman aircraft 10B.

[0041] The onboard terminal 20 includes a signal processor 30, an antenna selector 32, and a beam controller 34.

[0042] The signal processor 30 executes signal processing on various information that is transferred to and from the wingman aircraft 10B via the antennas 12.

[0043] The antenna selector 32 executes antenna selection processing for selecting one antenna 12 for communicating with the wingman aircraft 10B from among the multiple antennas 12.

[0044] The beam controller 34 controls a beam based on input wingman-aircraft position information so that the antenna 12 selected by the antenna selector 32 performs communication with the wingman aircraft 10.

[0045] Next, the various processes executed by the control unit 22 will be described in detail.

[0046] The antenna 12 receives wingman-aircraft information from the wingman aircraft 10B and outputs it to the signal processor 30 in the form of IF (Intermediate Frequency) signals. The wingman-aircraft information includes wingman-aircraft position information and information indicating the status of the wingman aircraft 10B (hereinafter referred to as "fuselage information") and is associated with the time when the wingman aircraft 10B obtained the wingman-aircraft information.

[0047] The signal processor 30 executes IF signal

processing and modulation/demodulation processing on the IF signals input from the antenna 12, generating digital signals. Furthermore, since the digital signals are encrypted, the signal processor 30 executes encoding processing on the digital signals to restore the wingman-aircraft information. Then, the signal processor 30 outputs the wingman-aircraft information to the computer 26 and outputs the wingman-aircraft position information included in the wingman-aircraft information to the beam controller 34. The wingman-aircraft position information is expressed in the form of three-dimensional coordinates $P_{(t)}(X_{(t)}, Y_{(t)}, Z_{(t)})$ at time t when the wingman-aircraft position information was obtained.

[0048] The computer 26 predicts the current position of the wingman aircraft 10B based on a temporal change in the wingman-aircraft position information included in the wingman-aircraft information input from the signal processor 30 and outputs the prediction result (hereinafter referred to as "predicted current position") as wingman-aircraft predicted position information.

[0049] Examples of the method of predicting the current position of the wingman aircraft 10B include a velocity predicting method, an acceleration predicting method, and a circular-path predicting method.

[0050] In the velocity predicting method, as shown in Fig. 4, assuming that the wingman aircraft 10B is moving in a straight line at a constant velocity, the current position of the wingman aircraft 10B is predicted by calculating the velocity $V(t)$ of the wingman aircraft 10B based on a temporal change in the wingman-aircraft position information.

[0051] In the acceleration predicting method, as shown in Fig. 5, assuming that the wingman aircraft 10B is moving in a straight line at a constant acceleration, the current position of the wingman aircraft 10B is predicted by calculating the acceleration $a(t)$ of the wingman aircraft 10B based on a temporal change in the wingman-aircraft position information.

[0052] In the circular-path predicting method, as shown in Fig. 6, assuming that the wingman aircraft 10B is moving in a circular path, the current position of the wingman aircraft 10B is predicted by calculating the center of the circular path, the angular velocity ω , and the revolving radius R based on a temporal change in the wingman-aircraft position information.

[0053] Of the velocity predicting method, the acceleration predicting method, and the circular-path predicting method, it is preferable to predict the current position of the wingman aircraft 10B by using the velocity predicting method since the predicted current position of the wingman aircraft 10B obtained by using the velocity predicting method is more approximate to the actual position (real position) compared with the other methods.

[0054] The computer 26 outputs the wingman-aircraft predicted position information to the antenna selector 32 together with the own-aircraft position information input from the own-aircraft-position measuring device 24.

[0055] It is to be noted that the amount of change in

the relative position of the aircraft 10A and the wingman aircraft 10B strongly depends on the change in the roll of the aircraft 10A rather than the relative velocity of the aircraft 10A and the wingman aircraft 10B.

[0056] That is, as shown in Fig. 7, the maximum roll rate (deg/S) of the aircraft 10A is higher compared with the angle A (deg/S) representing the amount of change in the relative position in the case where the aircraft 10A and the wingman aircraft 10B pass by each other at high speed. Therefore, the amount of change in the relative position of the aircraft 10A and the wingman aircraft 10B is large.

[0057] Thus, the antenna selector 32 selects an antenna 12 with which the elongation with respect to the center axis of the antenna 12 at the predicted current position of the wingman aircraft 10B falls within the coverage angle from among the multiple antennas 12 (antenna selection processing).

[0058] To describe the elongation more specifically with reference to Fig. 8, the elongation ϕ_t is the angle formed by the straight line connecting the center position of the antenna 12 and the predicted current position (the broken line in Fig. 8) and the line of the center axis of the antenna 12 (the solid line in Fig. 8).

[0059] Fig. 9 is a flowchart (antenna selecting program) showing the procedure of the antenna selection processing executed by the antenna selector 32. The antenna selecting program is stored in advance in a predetermined area of a storage means (e.g., a ROM) provided in the onboard terminal 20. The antenna selection processing is executed when the aircraft 10A performs communication with the wingman aircraft 10B.

[0060] First, in step 100, a waiting state continues until wingman-aircraft predicted position information is input. When wingman-aircraft predicted position information is input, the procedure proceeds to step 102.

[0061] In step 102, an antenna 12 with which the elongation ϕ_t with respect to the center axis of the antenna 12 at the predicted current position of the wingman aircraft 10B falls within the coverage angle θ is selected. The coverage angle θ of each antenna 12 is stored in advance.

[0062] The antenna 12 with which the elongation ϕ_t falls within the coverage angle θ is an antenna 12 with which it is possible to establish communication with the wingman aircraft 10B. Furthermore, considering changes in the relative position of the aircraft 10A and the wingman aircraft 10B due to changes in the roll of the aircraft 10A, it is preferable to select an antenna 12 for executing communication with the wingman aircraft 10B with reference to the elongation ϕ_t of the current position of the wingman aircraft 10B and the center axis of the antenna 12.

[0063] Next, in step 104, it is determined whether multiple antennas 12 have been selected in step 102. The procedure proceeds to step 106 in the case where the result is yes, whereas the procedure proceeds to step 108 in the case where the result is no. Since the coverage

angle θ of each antenna 12 of the aircraft 10 according to this embodiment overlaps the coverage angle θ of at least one other antenna 12 as shown in Fig. 2, there are cases where multiple antennas 12 are selected in step 102.

[0064] In step 106, an antenna 12 that is optimal for communication with the wingman aircraft 10B is selected from among the multiple antennas 12 selected in step 102. In this step 106, one optimal antenna 12 is selected based on the difference between the coverage angle θ and the elongation ϕ_t of each of the selected multiple antennas 12.

[0065] In this step 106, in order to select an optimal antenna 12, an antenna 12 with which the difference between the coverage angle θ and the elongation ϕ_t ($\theta - \phi_t$, hereinafter referred to as the "coverage-angle margin") is the greatest (a first factor), antennas 12 with which the coverage-angle margin is greater than or equal to a predetermined constant k ($\theta - \phi_t \geq k$) (a second factor), and antennas 12 with which the coverage-angle margin is greater compared with the last communication (the last time the antenna 12 was selected) ($\theta - \phi_t \geq \theta - \phi_{t-1}$) (a third factor) are extracted. The constant k is determined in advance based on, for example, the time needed for communication with the wingman aircraft 10B, the maximum roll rate of the aircraft 10A, and the ratio of the overlapping region to the coverage angle.

[0066] The antenna 12 with the greatest coverage-angle margin is an antenna with the greatest tolerance for communication with the wingman aircraft 10B. Furthermore, the antennas 12 with which the coverage-angle margin is greater than or equal to the predetermined constant k are antennas 12 with which it is possible to perform communication with the wingman aircraft 10B more reliably. Furthermore, the antennas 12 with which the coverage-angle margin is greater compared with the last communication are antennas 12 with which the communication conditions with the wingman aircraft 10B are better compared with the last communication.

[0067] Then, in step 106, the antenna 12 satisfying the first factor is weighted by a first predetermined value, the antennas 12 satisfying the second factor are weighted by a second predetermined value, the antennas 12 satisfying the third factor are weighted by a third predetermined value, and the antenna 12 with the greatest total value is selected as an optimal antenna 12. Thus, in the antenna selection processing, the antenna 12 with the least elongation ϕ_t is selected by comprehensively evaluating the coverage-angle margin of each of the antennas 12, which makes it possible to select a more optimal antenna 12.

[0068] For example, the order of the values of the weights from larger to smaller is the first predetermined value, the second predetermined value, and the third predetermined value.

[0069] Then, in step 108, selected-antenna information indicating the selected antenna 12 is output to the signal processor 30 and the beam controller 34.

[0070] When the selected-antenna information is input, the signal processor 30 outputs IF signals obtained by converting the own-aircraft information to the antenna 12 indicated by the selected-antenna information.

[0071] The own-aircraft information is information including the fuselage information and own-aircraft position information of the aircraft 10A, and it is output from the computer 26 to the signal processor 30. The signal processor 30 obtains the accurate time of acquisition of the own-aircraft information by correcting the time information input from the own-aircraft-position measuring device 24 according to the time correction information input from the atomic clock unit 28 and executes encoding processing, modulation/demodulation processing, and IF signal processing on the own-aircraft information to convert it into IF signals.

[0072] When the selected-antenna information is input, the beam controller 34 generates a beam controlling signal and outputs it to the selected antenna 12 such that the selected antenna 12 radiates a beam in the direction where the wingman aircraft 10B is located. The position of the wingman aircraft 10B to which the beam is to be radiated is the position of the wingman aircraft 10B indicated by the input wingman-aircraft position information. The beam controller 34 calculates the direction in which the wingman aircraft 10B is located based on the position of the wingman aircraft 10B and the position of the aircraft 10A.

[0073] Through the processing described above, the own-aircraft information is transmitted to the wingman aircraft 10B via the antenna 12 selected through the antenna selection processing.

[0074] The antenna selection processing returns to step 100 when the processing in step 108 is finished, and the processing from step 100 to step 108 is repeated during communication with the wingman aircraft 10B. The control unit 22 according to this embodiment can track the wingman aircraft 10B at high speed by executing the processing from step 100 to step 108 at high speed.

[0075] In the case where communication is performed with multiple wingman aircrafts 10B, the control unit 22 executes the antenna selection processing for each of the wingman aircrafts 10B with which communication is to be performed and performs communication while shifting the timing for each of the wingman aircrafts 10B.

[0076] As described above, the control unit 22 of the aircraft 10 according to this embodiment includes the computer 26 that predicts the current position of the wingman aircraft 10B based on a temporal change in the wingman-aircraft position information indicating the position of the wingman aircraft 10B, the antenna selector 32 that selects, from among the multiple antennas 12, an antenna 12 with which the elongation ϕ_t with respect to the center axis of the antenna 12 at the predicted current position of the wingman aircraft 10B predicted by the computer 26 falls within the coverage angle θ , and the beam controller 34 that executes communication with the wingman aircraft 10B via the antenna 12 selected by the

antenna selector 32.

[0077] Thus, the control unit 22 of the aircraft 10 can select an optimal antenna 12 for communication with the wingman aircraft 10B from among the multiple antennas 12.

[0078] Although the present invention has been described above in the context of the above-described embodiment, the technical scope of the present invention is not limited to the scope of the above-described embodiment. It is possible to modify or improve the above-described embodiment in various ways without departing from the scope of the invention, and embodiments involving the modifications or improvements are also encompassed within the technical scope of the present invention as defined by the appended claims.

[0079] For example, although an optimal antenna 12 is selected by using the first factor, the second factor, and the third factor in the case where multiple antennas 12 have been selected through the antenna selection processing in the above-described embodiment, the present invention is not limited to this embodiment. An optimal antenna 12 may be selected by using other factors without limitation to the first factor, the second factor, and the third factor, or an optimal antenna 12 may be selected by using one or two of the first factor, the second factor, and the third factor.

[0080] Furthermore, although the position of the wingman aircraft 10B to which a beam is to be radiated is the position of the wingman aircraft 10B indicated by the wingman-aircraft position information input to the beam controller 34 in the above-described embodiment, the present invention is not limited to this embodiment. Alternatively, wingman-aircraft predicted position information may be input to the beam controller 34 so that the position of the wingman aircraft 10B to which a beam is to be radiated becomes the predicted current position of the wingman aircraft 10B indicated by the wingman-aircraft predicted position information input to the beam controller 34.

[0081] Furthermore, the flow of the antenna selection processing (antenna selecting program) in the above-described embodiment is also just an example, and unnecessary steps may be removed, new steps may be added, and the order of processing may be changed without departing from the scope of the present invention as defined by the appended claims.

{Reference Signs List}

[0082]

10	Aircrafts
10A	Aircraft
10B	Wingman aircraft
12	Antennas
20	Onboard terminal
32	Antenna selector
34	Beam controller

Claims

1. An antenna controlling device for an aircraft (10A) having multiple antennas (12) for communicating with a wingman aircraft (19B), the multiple antennas (12) being provided at different points on a fuselage, the aircraft-antenna controlling device comprising:

a wingman-aircraft-position predicting means (26) for predicting the current position of the wingman aircraft (10B) based on a temporal change in position information indicating the position of the wingman aircraft (10B);

a selecting means (32) for selecting, from among the multiple antennas (12), an antenna with which the elongation with respect to the center axis of the antenna at the current position of the wingman aircraft (12B) predicted by the wingman-aircraft-position predicting means (26) falls within a coverage angle of the antenna; and

a communication controlling means (34) for executing communication with the wingman aircraft (10B) via the antenna selected by the selecting means (32),

wherein, in the case where multiple antennas (12) have been selected by the selecting means (32), one of the selected multiple antennas (12) is selected based on the difference between the coverage angle and the elongation of each of the antennas (12).

2. An aircraft-antenna controlling device according to Claim 1, wherein the coverage angle of the antenna overlaps the coverage angle of an adjacent one of the other antennas (12).

3. An aircraft-antenna controlling device according to Claim 2, wherein one antenna is selected from among the antenna (12) with the greatest difference between the coverage angle and the elongation, the antennas (12) with which the difference is greater than or equal to a predetermined constant, and the antennas (12) with which the difference is greater compared with the last communication.

4. An aircraft-antenna controlling device according to Claim 3, wherein the antenna (12) with the greatest difference between the center axis and the elongation, the antennas (12) with which the difference is greater than or equal to the constant, and the antennas (12) with which the difference is greater compared with the last communication are weighted individually by predetermined values, and the antenna (12) with the greatest total value of the results is selected.

5. An aircraft comprising:

multiple antennas (12) for communicating with a wingman aircraft (10B), the multiple antennas (12) being provided at different points on a fuselage; and
an antenna controlling device according to any one of Claims 1 to 4.

6. An antenna selecting program for an aircraft (10A) having multiple antennas (12) for communicating with a wingman aircraft (10B), the multiple antennas (12) being provided at different points on a fuselage, wherein the aircraft-antenna selecting program is a program for causing a computer to function as a selecting means (32) for selecting, from among the multiple antennas (12), an antenna with which the elongation with respect to the center axis of the antenna at the current position of the wingman aircraft (10B) predicted based on a temporal change in position information indicating the position of the wingman aircraft (10B) falls within a coverage angle of the antenna; and
wherein, in the case where multiple antennas (12) have been selected by the selecting means (32), one of the selected multiple antennas (12) is selected based on the difference between the coverage angle and the elongation of each of the antennas (12).

7. An antenna controlling method for an aircraft (10A) having multiple antennas (12) for communicating with a wingman aircraft (10B), the multiple antennas (12) being provided at different points on a fuselage, the aircraft-antenna controlling method comprising:

a first step of predicting the current position of the wingman aircraft (10B) based on a temporal change in position information indicating the position of the wingman aircraft (10B);

a second step of selecting, from among the multiple antennas (12), an antenna with which the elongation with respect to the center axis of the antenna at the predicted current position of the wingman aircraft (10B) falls within a coverage angle of the antenna; and

a third step of executing communication with the wingman aircraft (10B) via the selected antenna; and

wherein, in the case where multiple antennas (12) have been selected by the selecting step, one of the selected multiple antennas (12) is selected based on the difference between the coverage angle and the elongation of each of the antennas (12).

Patentansprüche

1. Antennensteuervorrichtung für ein Flugzeug (10A) (bzw. Flugzeugantennensteuervorrichtung) mit einer Vielzahl von Antennen (12) zum Kommunizieren mit einem Wingman-Flugzeug (10B), wobei die Vielzahl von Antennen (12) an unterschiedlichen Punkten an einem Rumpf vorgesehen sind, wobei die Flugzeugantennensteuervorrichtung aufweist:

eine Wingman-Flugzeug-Positionsvorhersageeinrichtung (26) zum Vorhersagen der gegenwärtigen Position des Wingman-Flugzeugs (10B) basierend auf einer zeitlichen Änderung von die Position des Wingman-Flugzeugs (10B) anzeigenden Positionsinformationen; eine Auswahleinrichtung (32) zum Auswählen einer Antenne aus der Vielzahl von Antennen (12), mit welcher die Verlängerung bezüglich der Mittelachse der Antenne an der durch die Wingman-Flugzeug-Positionsvorhersageeinrichtung (26) vorhergesagten gegenwärtigen Position des Wingman-Flugzeugs (10B) in einen Abdeckwinkel der Antenne fällt; und eine Kommunikationssteuereinrichtung (34) zum Ausführen einer Kommunikation mit dem Wingman-Flugzeug (10B) über die durch die Auswahleinrichtung (32) ausgewählte Antenne, wobei, für den Fall, in welchem die Vielzahl von Antennen (12) durch die Auswahleinrichtung (32) ausgewählt worden sind, eine der ausgewählten Vielzahl von Antennen (12) basierend auf der Differenz zwischen dem Abdeckwinkel und der Verlängerung von jeder der Antennen (12) ausgewählt wird.

2. Flugzeugantennensteuervorrichtung nach Anspruch 1, wobei der Abdeckwinkel der Antenne den Abdeckwinkel einer benachbarten von den anderen Antennen (12) überlappt.

3. Flugzeugantennensteuervorrichtung nach Anspruch 2, wobei eine Antenne unter der Antenne (12) mit der größten Differenz zwischen dem Abdeckwinkel und der Verlängerung, den Antennen (12), mit welchen die Differenz größer oder gleich einer vorbestimmten Konstanten ist, und den Antennen (12), mit welchen die Differenz verglichen zu der letzten Kommunikation größer ist, ausgewählt wird.

4. Flugzeugantennensteuervorrichtung nach Anspruch 3, wobei die Antenne (12) mit der größten Differenz zwischen der Mittelachse und der Verlängerung, die Antennen (12), mit welchen die Differenz größer oder gleich der Konstanten ist, und die Antennen (12), mit welchen die Differenz verglichen zu der letzten Kommunikation größer ist, durch vorbe-

stimmte Werte individuell gewichtet werden, und die Antenne (12) mit dem größten Gesamtwert der Ergebnisse ausgewählt wird.

5. Flugzeug mit:

einer Vielzahl von Antennen (12) zum Kommunizieren mit einem Wingman-Flugzeug (10B), wobei die Vielzahl von Antennen (12) an unterschiedlichen Punkten an einem Rumpf vorgesehen sind; und einer Antennensteuervorrichtung nach einem der Ansprüche 1 bis 4.

6. Antennenauswahlprogramm für ein Flugzeug (10A) (bzw. Flugzeugantennenauswahlprogramm) mit einer Vielzahl von Antennen (12) zum Kommunizieren mit einem Wingman-Flugzeug (10B), wobei die Vielzahl von Antennen (12) an unterschiedlichen Punkten an einem Rumpf vorgesehen sind, wobei das Flugzeugantennenauswahlprogramm ein Programm ist, um zu bewirken, dass ein Computer als eine Auswahleinrichtung (32) dient zum Auswählen einer Antenne aus der Vielzahl von Antennen (12), mit welcher die Verlängerung bezüglich der Mittelachse der Antenne an der basierend auf einer zeitlichen Änderung von die Position des Wingman-Flugzeugs (10B) anzeigenden Positionsinformationen vorhergesagten gegenwärtigen Position des Wingman-Flugzeugs (10B) in einen Abdeckwinkel der Antenne fällt, und wobei, für den Fall, in welchem die Vielzahl von Antennen (12) durch die Auswahleinrichtung (32) ausgewählt worden sind, eine der ausgewählten Vielzahl von Antennen (12) basierend auf der Differenz zwischen dem Abdeckwinkel und der Verlängerung von jeder der Antennen (12) ausgewählt wird.

7. Antennensteuerverfahren für ein Flugzeug (10A) (bzw. Flugzeugantennensteuerverfahren) mit einer Vielzahl von Antennen (12) zum Kommunizieren mit einem Wingman-Flugzeug (10B), wobei die Vielzahl von Antennen (12) an unterschiedlichen Punkten an einem Rumpf vorgesehen sind, wobei das Flugzeugantennensteuerverfahren aufweist:

einen ersten Schritt zum Vorhersagen der gegenwärtigen Position des Wingman-Flugzeugs (10B) basierend auf einer zeitlichen Änderung von die Position des Wingman-Flugzeugs (10B) anzeigenden Positionsinformationen; einen zweiten Schritt zum Auswählen einer Antenne aus der Vielzahl von Antennen (12), mit welcher die Verlängerung bezüglich der Mittelachse der Antenne an der vorhergesagten gegenwärtigen Position des Wingman-Flugzeugs (10B) in einen Abdeckwinkel der Antenne fällt; und

einen dritten Schritt zum Ausführen einer Kommunikation mit dem Wingman-Flugzeug (10B) über die ausgewählte Antenne; und wobei, für den Fall, in welchem die Vielzahl von Antennen (12) durch den Auswahlsschritt ausgewählt worden sind, eine der ausgewählten Vielzahl von Antennen (12) basierend auf der Differenz zwischen dem Abdeckwinkel und der Verlängerung von jeder der Antennen (12) ausgewählt wird.

Revendications

1. Dispositif de commande d'antenne d'avion (10A), ayant des antennes (12) multiples pour communiquer avec un avion (19B) d'ailier, les antennes (12) multiples étant prévues en des points différents d'un fuselage, le dispositif de commande d'antenne d'ailier comprenant :

un moyen (26) de prédiction de la position de l'avion d'ailier pour prédire la position présente de l'avion (10B) d'ailier sur la base d'un changement temporel d'une information de position indiquant la position de l'avion (10B) d'ailier ;
un moyen (32) de sélection pour sélectionner parmi les antennes (12) multiples une antenne par laquelle l'allongement par rapport à l'axe central de l'antenne à la position présente de l'avion (12B) d'ailier prédite par le moyen (26) de prédiction de la position d'avion d'ailier se trouve dans un angle de couverture de l'antenne et
un moyen (34) de commande de communication pour exécuter une communication avec l'avion (10B) d'ailier par l'intermédiaire de l'antenne sélectionnée par le moyen (32) de sélection, dans lequel, dans le cas où des antennes (12) multiples ont été sélectionnées par le moyen (32) de sélection, l'une des antennes (12) multiples sélectionnées est sélectionnée sur la base de la différence entre l'angle de couverture et l'allongement de chacune des antennes (12).

2. Dispositif de commande d'antenne d'avion suivant la revendication 1, dans lequel l'angle de couverture de l'antenne recouvre l'angle de couverture de l'une voisine des autres antennes (12).
3. Dispositif de commande d'antenne d'avion suivant la revendication 2, dans lequel une antenne est sélectionnée parmi l'antenne (12) ayant la différence la plus grande entre l'angle de couverture et l'allongement, les antennes (12), dans lesquelles la différence est supérieure ou égale à une constante déterminée à l'avance, et les antennes (12), dans les-

quelles la différence est plus grande par rapport à la dernière communication.

4. Dispositif de commande d'antenne d'avion suivant la revendication 3, dans lequel l'antenne (12) ayant la différence la plus grande entre l'axe central et l'allongement, les antennes (12), dans lesquelles la différence est supérieure ou égale à la constante, et les antennes (12), dans lesquelles la différence est plus grande que dans la dernière communication, sont pondérées individuellement par des valeurs déterminées à l'avance et l'antenne (12) ayant la valeur totale la plus grande des résultats est sélectionnée.

5. Avion comprenant :

les antennes (12) multiples pour communiquer avec un avion (10B) d'ailier, les antennes (12) multiples étant prévues en des points différents sur un fuselage et
un dispositif de commande d'antenne suivant l'une quelconque des revendications 1 à 4.

6. Programme de sélection d'antenne pour un avion (10A) ayant des antennes (12) multiples pour communiquer avec un avion (10B) d'ailier, les antennes (12) multiples étant prévues en des points différents sur un fuselage, dans lequel le programme de sélection d'antenne d'avion est un programme pour faire qu'un ordinateur fonctionne en moyen (32) de sélection pour sélectionner, parmi les antennes (12) multiples, une antenne dont l'allongement par rapport à l'axe central de l'antenne à la position présente de l'avion (10B) d'ailier prédite sur la base d'un changement temporel d'une information de position indiquant la position de l'avion (10B) d'ailier soit compris dans un angle de couverture de l'antenne et dans lequel, dans le cas où des antennes (12) multiples ont été sélectionnées par le moyen (32) de sélection, l'une des antennes (12) multiples sélectionnées est sélectionnée sur la base de la différence entre l'angle de couverture et l'allongement de chacune des antennes (12).

7. Procédé de commande d'antenne pour un avion (10A) ayant des antennes (12) multiples pour communiquer avec un avion (10B) d'ailier, des antennes (12) multiples étant prévues en des points différents sur un fuselage, le procédé de commande d'antenne d'avion comprenant :

un premier stade de prédiction de la position présente de l'avion (10B) d'ailier sur la base d'un changement temporel d'une information de position indiquant la position de l'avion (10B) d'ailier ;
un deuxième stade de sélection, parmi les an-

tennes (12) multiples, d'une antenne dont l'allongement par rapport à l'axe central de l'antenne à la position présente prédite de l'avion (10B) d'ailier est compris dans un angle de couverture de l'antenne et

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un troisième stade d'exécution d'une communication avec l'avion (10B) d'ailier par l'antenne sélectionnée et

dans lequel, dans le cas où des antennes (12) multiples ont été sélectionnées par le stade de sélection, l'une des antennes (12) multiples sélectionnées est sélectionnée sur la base de la différence entre l'angle de couverture et l'allongement de chacune des antennes (12).

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FIG. 1

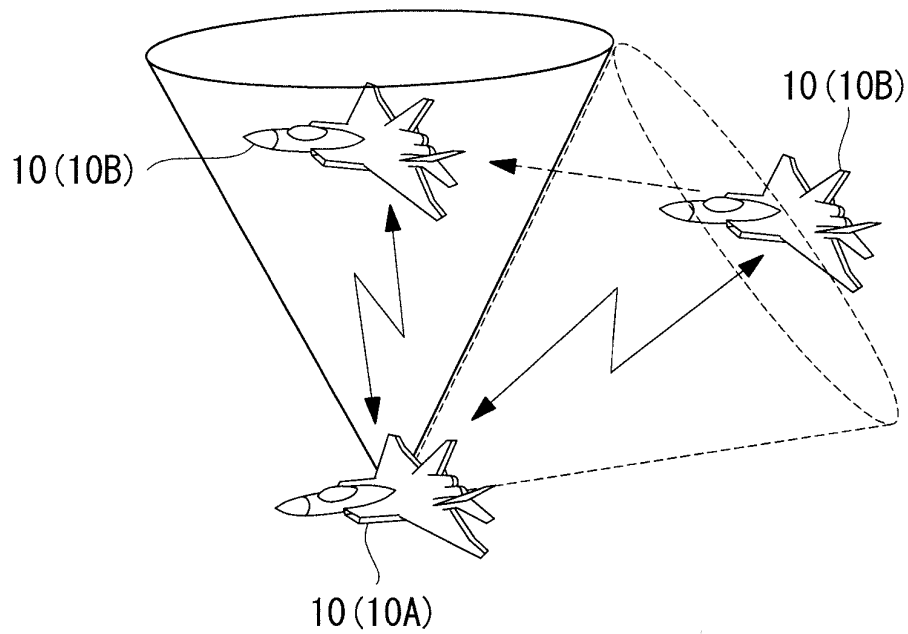


FIG. 2

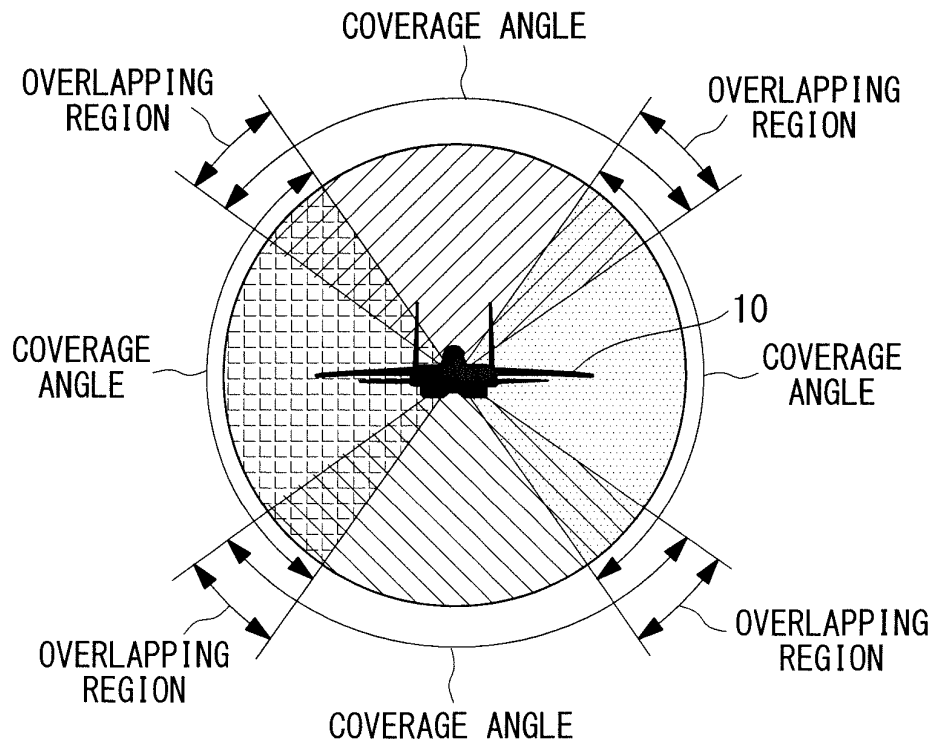


FIG. 3

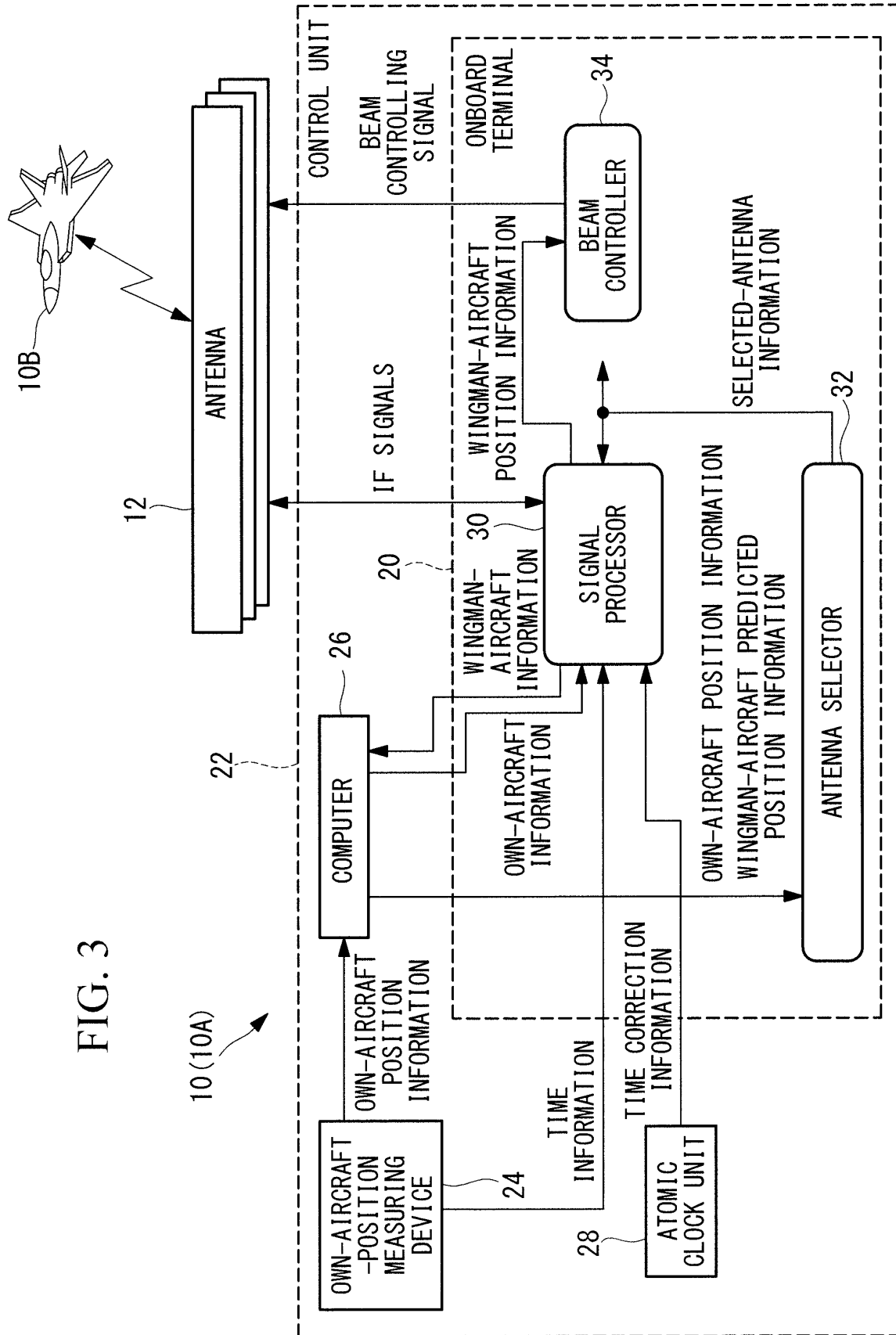


FIG. 4

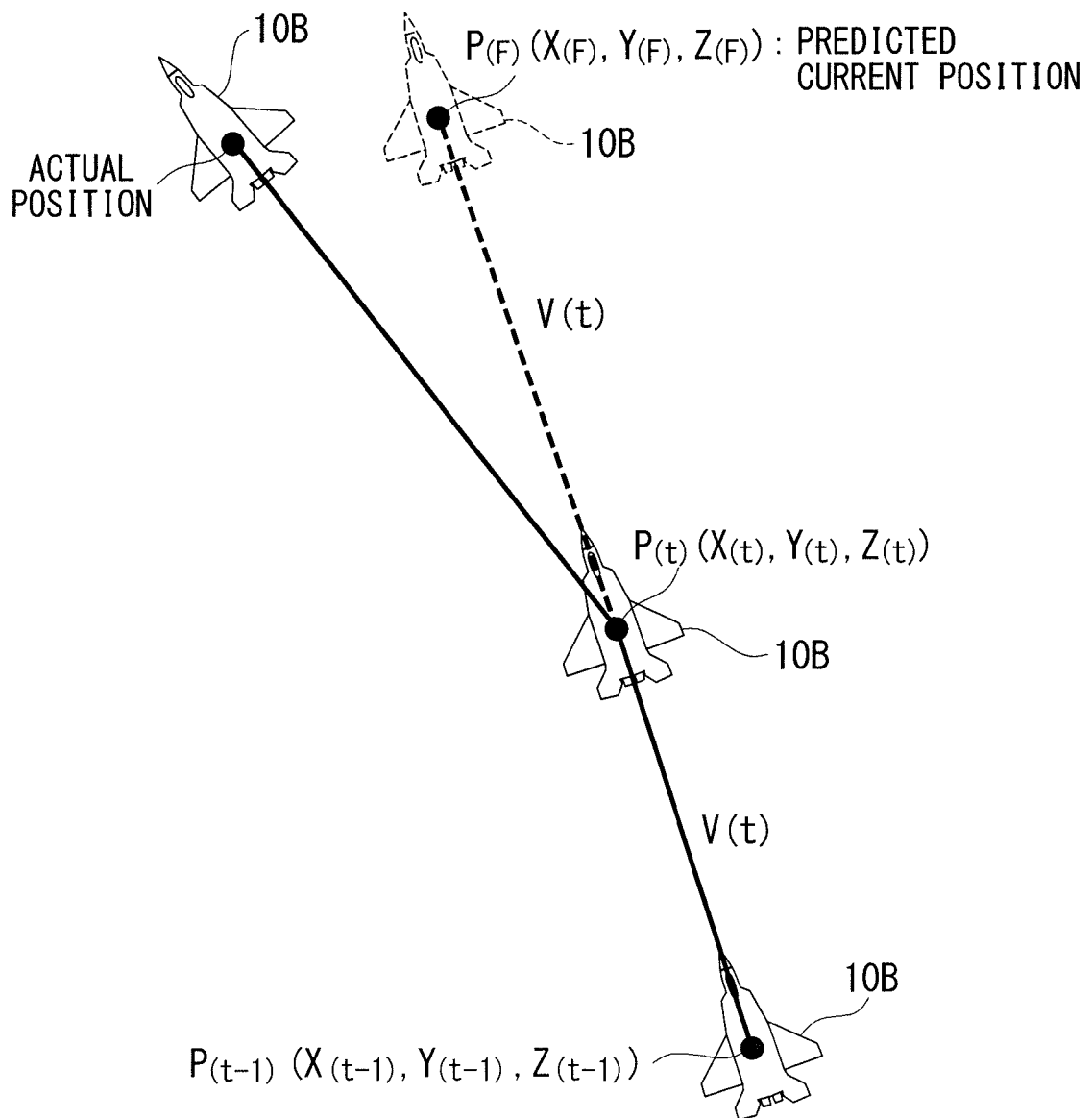


FIG. 5

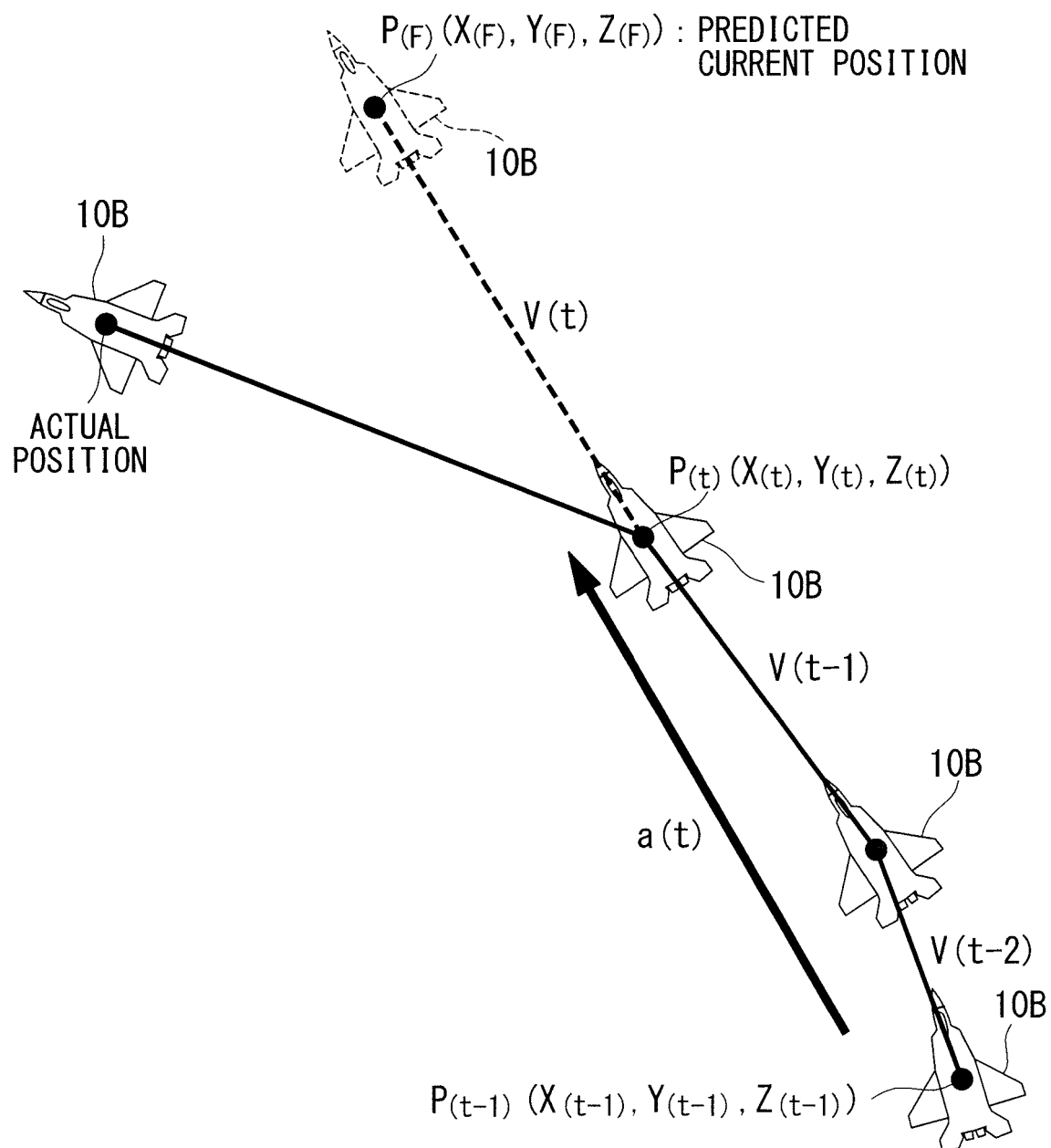


FIG. 6

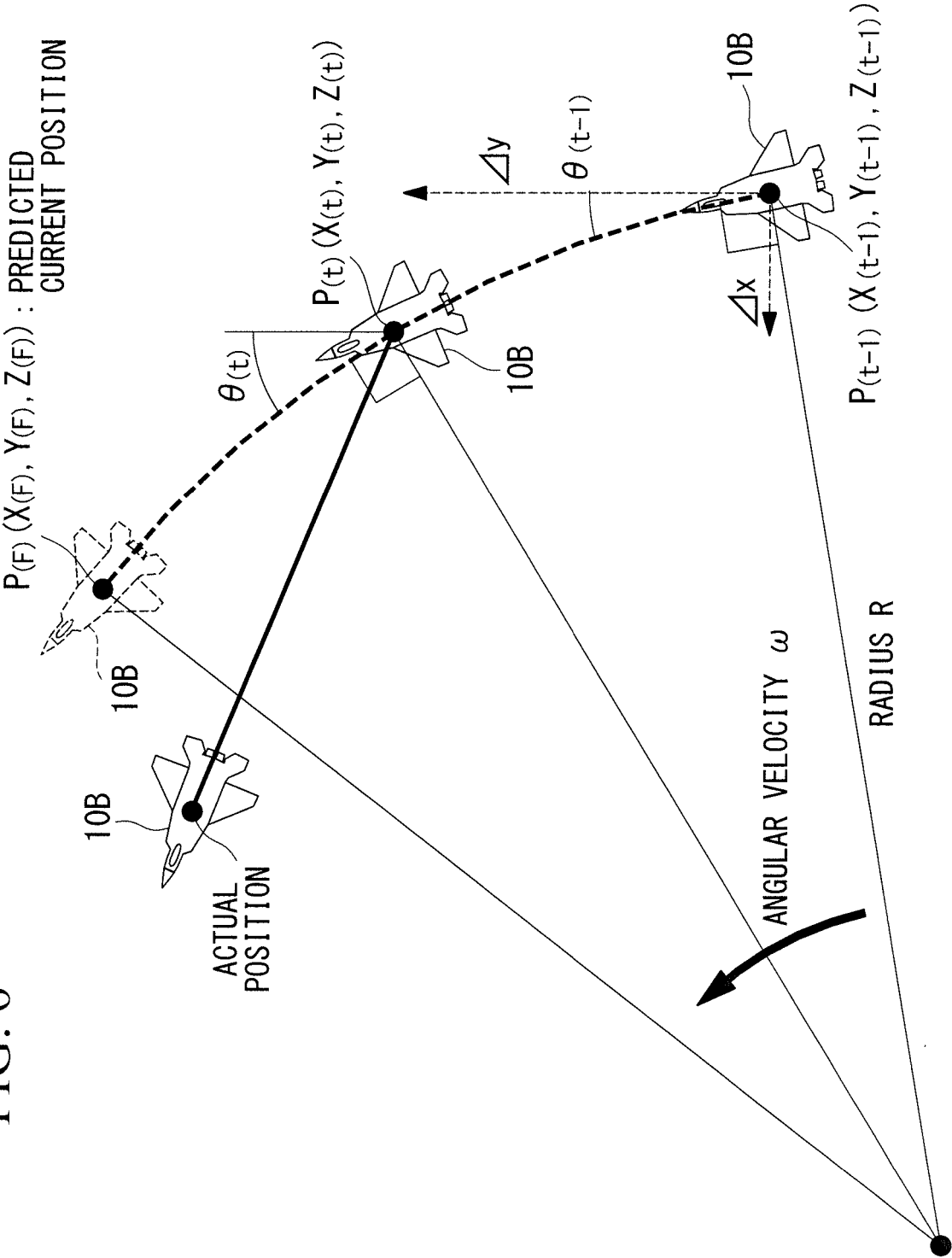


FIG. 7

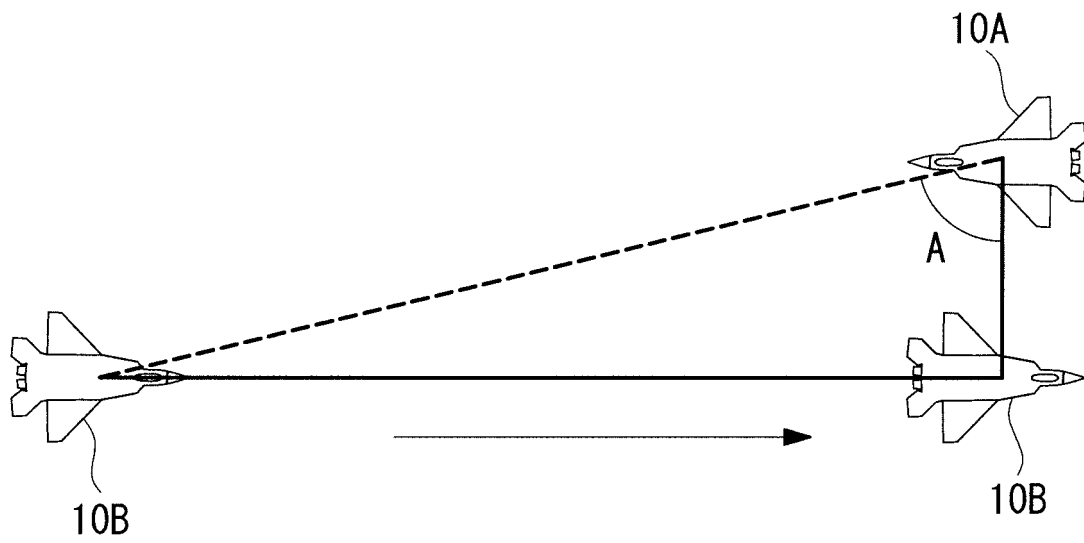


FIG. 8

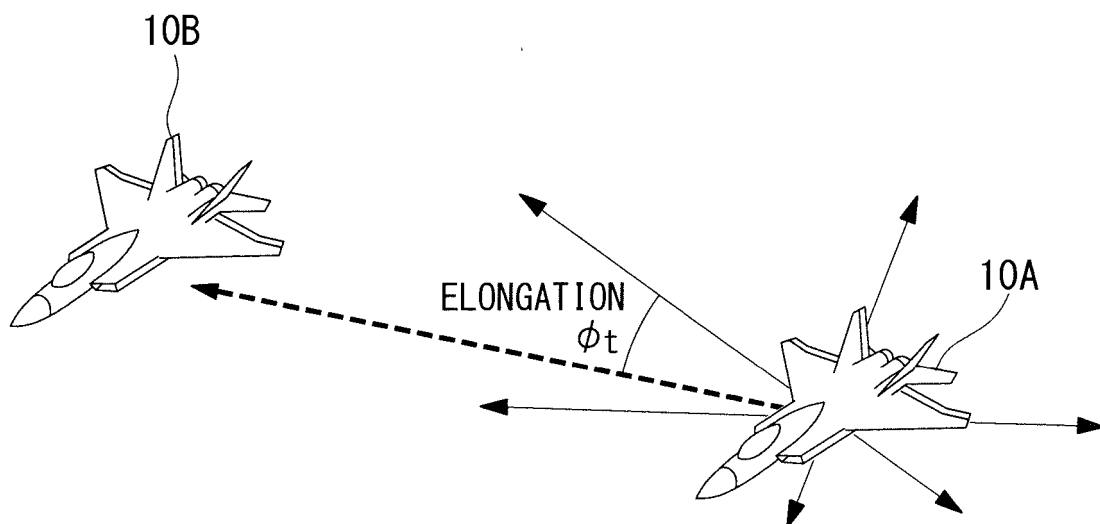
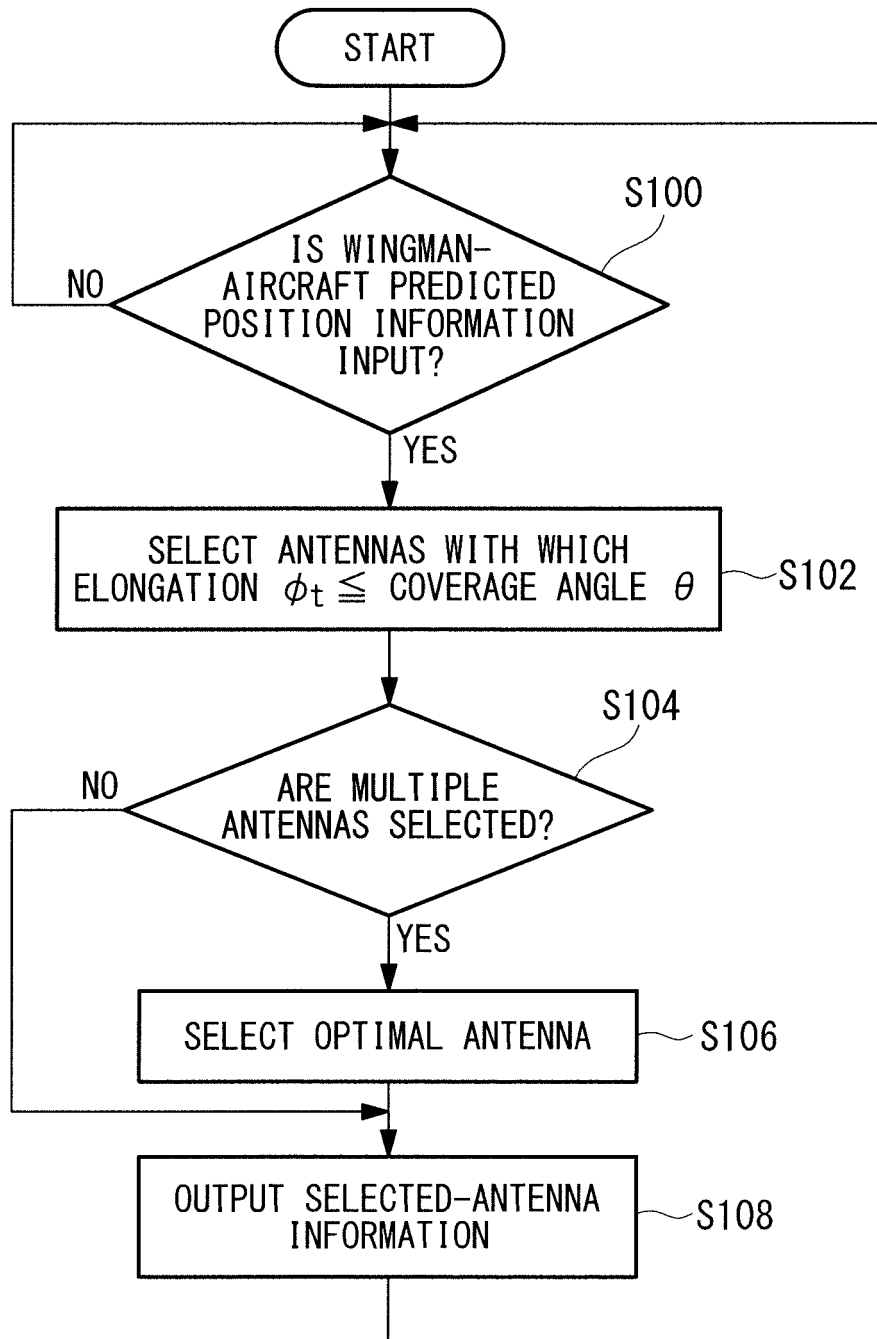


FIG. 9



REFERENCES CITED IN THE DESCRIPTION

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